Effective preservation decision strategies.

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Introduction [Heading]

This paper aims to advise conservators and others on how to recognise different modes of decision making. It does not seek to be a comprehensive treatise on decision making strategies. Rather, it aims to discuss and describe two types of mental processes involved in decision making: heuristic and analytic-deliberative, placing them in an appropriate context whilst identifying the limitations of each. The goal of introducing the concepts of decision making theory into the field is so they can be more thoroughly explored by people working on theory of and training for conservation. The intent in presenting this information is to increase within the fields of conservation theory and conservation education, awareness of the value of recognizing how these two types of thinking contribute both to decision making in general and to conservation decisions in particular. For simplicity of writing the term 'conservator' is used in this paper to encompass all those working to understand, safeguard and enhance cultural heritage (UNESCO 1994).

While not the primary goal of this paper it is also expected that conservation practitioners could use this paper to motivate reflection on ways their decisions are made and to identify instances where a change in how they think about decisions might be beneficial. Conservators may participate in decision making processes by contributing data or expert opinion to a group of opinion formers, or they may be involved in making their own decisions such as allocating their own resources. In many contexts the social rules for decision making may be fixed: being mindful of thought processes leading to the decision will be beneficial.

Principles of decision making [heading]

We make decisions, including professional decisions about preservation issues, both deliberatively and in real time. Deliberative decision making can be rational and provide essential guidance on long-term issues including requirements for preservation. These decision processes tend to be time intensive as they must be structured, evidence-based, and seek to be comprehensive. Within the preservation field there are exemplars of analytic-deliberative decision models such as the Cultural Property Risk Analysis Model (CPRAM) (Waller 2003, 2008a&b), which are being increasingly adopted in the heritage sector (Macedo and Waller 2011). In life, the vast majority of decisions are made instinctively, based on past experience and without insight into the process. If, in life, heuristics dominate decision making then those working to care for our cultural heritage do utilise heuristics whether they recognise it or not. Heuristic decisions may be made by recognising similarities with past situations and adapting behaviour: these decisions may

feel instinctive such as experiencing a sense of correctness when adjusting a display mount during the installation of an object. Our approach to decision making is always influenced and often defined by available resources, especially time. The decision making process can be either explicit or implicit (Baer and Snickars 2001, 278). This means that individuals will be aware that they are making decisions in some contexts more than in others. Modes of decision making are 'a continuum, not a dichotomy' (Kahneman 2003, 700), gaining insight into the decision making process will enable conservators to mindfully select and enact appropriate decision making strategies.

When considering effective decision making, the ideal starting point is to examine and understand the problem or question that has instigated the process. Through clarity and insight into the problem a good decision making strategy can be selected: until you have a clear question you cannot expect a clear answer. Creating a good question is a significant challenge and many difficult decision processes stem from a lack of clarity at the outset.

It is tempting to assess the quality of a decision making process by the desirability of the outcomes. Although it is true that a good decision process will often lead to a desired outcome, when dealing with situations that involve uncertainty, it is possible to make wise choices that end with a poor outcome, just as it is possible to make a decision on a weak basis (the toss of a coin) but latch onto a good outcome. It is important not to confuse the quality of the process with the desirability of the outcome.

Definitions [sub heading]

The fields of decision and risk analysis have established vocabularies of their own. Presented here is a summary of terminology used in this paper which, although common in psychology or risk analysis, is less familiar in conservation.

Term	Definition
Analytic-deliberative process	A combination of technical assessment and dialogue to foster stakeholder participation and involvement in risk management (Renn 1999).
Attribute substitution	Answering a difficult question by substituting an answer that comes more readily to mind 'the essence of attribute substitution is that respondents offer a reasonable answer to a question that they have not been asked' (Kahneman 2003, 709).
Broad framing	Considering many variables in assessing a situation especially considering the longer term. Could be described as 'seeing the bigger picture' (Kahneman 2011).

Correspondence	How well a model matches reality.
Coherence	Logical consistency of an argument.
Cue	A perceived prompt or signal that can guide choices.
Decision perspectives:	
descriptive	How individuals or groups actually do make decisions (Edwards, et al 2007).
normative	How individuals or groups should make decisions to obtain the best expected result (Edwards, et al 2007).
prescriptive	How actual, not idealised, people or groups should make decisions for the best expected results given realistic limitations on resources to make a decision (Edwards, et al 2007).
Experiential learning	To learn through practical experience, 'learning by doing'(Kolb 1984).
Heuristics	Intuitive processes for arriving at decisions by considering only one or a few variables.

Table 1. Terminology as used in the field of psychology, decision theory, and risk analysis.

In the field of decision analysis, distinctions are made between normative, descriptive, and prescriptive theories of decision analysis (Edwards, et al 2007) to distinguish respectively between theoretically ideal, actually observed, and practically recommended forms of decision making. This distinction is important as it helps to engage the conservator in a process of reflection on their decision making. For example within the debates on environmental standards it is possible to organise a more honest debate by separating what is apparently desirable (normative) from what is actually happening (descriptive) and finally proposing pragmatic solutions (prescriptive) (Ashley-Smith 1994).

Type 1 and Type 2 thinking [sub heading]

There are many different strategies for decision making but for this paper we compare two forms of decision making. Naturalistic decision making (Klein 2009) is based largely on heuristic mental processes while the other form, analytic-deliberative decision making, relies heavily on reflective mental processes. These two kinds of thinking processes are defined within the dual-process theory of higher cognition (Evans and Stanovich 2013, Stanovich 1999, 2009; Kahneman 2011). Intuitive processes which are autonomous and do not require the use of working memory are described as Type 1 processes. Reflective

decisions making is described as Type 2 where the mind is engaged in hypothetical contemplation that requires the use of working memory.

Within psychology the term heuristic is generally used to describe an intuitive, Type 1 decision process. There is a variety of refinements on the term, for example Evans and Stanovich (2013) distinguish the defining features of heuristics from characteristics commonly associated with them. They describe the critical element of heuristics as being autonomous and not requiring the use of working memory.

The term analytic-deliberative (AD) (Stern and Fineberg 1996; Renn 1999) is used in this paper to describe Type 2 thinking, a system of applying stakeholder judgements, including subjective value judgements, within a rational analytical framework to arrive at quantitative or semi-quantitative evaluations of risk. In some literature the simpler term 'rational' is used in this context. The authors have avoided this due to the implication that alternative decision making types are by definition non-rational as that term has a pejorative connotation.

The dual process theory highlights significant contrasts and prompt questions about the divide between reported and actual decision making process. The authors believe that within the cultural heritage sector there are many benefits to be had from recognising heuristic decision making and accepting its appropriateness in many situations. They also suspect but cannot prove that the occurrence of heuristic decision making is under reported within the literature due to a discomfort in acknowledging the validity of the process. A failure to recognize the prevalence and validity of heuristic decision strategies could be impeding the ability of heritage professionals to improve quality in their decision making.

Characteristics of type 1 and type 2 thinking are summarised in table 2. This table can be used as a summary of the strengths and weaknesses of each form of decision making by comparing their properties. The features are compiled from a series of publications and reflect an aggregation and some simplification of typical, contrasting characteristics associated with each of the two types of thinking in dual process theory.

Type 1	Type 2
Fast	Slow
Automatic, Instinctive	Controlled
Quick & Immediate	Chosen
Little effort	Effortful
Parallel	Sequential
Impressions and feelings	Conscious reasoning
Intuitive	Reflective
Implicit knowledge	Explicit knowledge
Pragmatic	Logical
Contextualized	Abstract

Experience-based decision making	Consequential decision making
Simple	Complex
Frugal processing	Data heavy
Operates in uncertainty	Reduces uncertainty
Broad perspective	Focussed consideration
Default approach	Familiar in scientific conventions

Table 2 Common characteristics of type 1 and type 2 thinking (Frankish and Evans 2009, Stanovich 2009, Kahneman 2011, Evans and Stanovich 2013).

Goals [sub heading]

Having established a clear definition of the problem then next critical act is to create well-defined goals. If a goal is ill-defined it may be impossible to even characterise, much less, agree how to satisfy it. A feature of effective decision making strategies is to be clear on both the goals and sub goals of the project. The goal of a task in hand may be to carry out a survey to identify the highest priority collections for re-housing. Sub goals may be to carry out the project within budget and to be able to continue offering conservation support to an exhibition project whilst collecting that data. Clear goal setting at the outset creates conditions where decision makers (subject to valid feedback) can review experiences against defined, planned benefits and encourages a more honest assessment of the success of a project.

Time spent defining the nature of goals is worthwhile and could inform all forms of decision making. Answering questions such as: is the goal to rank a set of options in order; is it to pick out a best course of action or is it to quantify options; would help identify a satisfactory decision making process. Quantifying options can really only be done using scales and data and must therefore be a data rich, analytic process whereas ranking options by stakeholder preference is potentially suitable for heuristic decision making. For example, the selection of a building for temporary storage of collections may involve quantification of a limited number of factors such as thermal insulation (a maximum U value) or on rental cost or may involve selection from among several available options based on convenience, and neighbourhood suitability in addition to more easily quantified factors.

Attitude to Risk tolerance [sub heading]

When considering preservation decision making it is useful to reflect on both personal attitude to risk and the approach to risk that an institution or situation encourages. Having more choices generally increases the incentive to experiment and may lower the perceived risk associated with the decision (Gigerenzer *et al* 1999 p351). A surfeit of choices can lead to decision paralysis and dissatisfaction (Schwartz 2004) but this degree of choice is seldom a problem in the museum sector. With interventive conservation treatments, conservators often have few options (indeed some of the best treatment stories arise from situations in which there appeared to be no option) whereas preventive conservators have more options and consultants even more. In general, hands-on conservators tend to think about items

individually and preventive conservators collectively. This collective view may encourage preventive conservators to consider problems in a wider context, which generally increases tolerance to any individual risk. Furthermore consultant (external) preventive conservators, being less constrained within a single institution's self-perception, and having the perspectives of multiple operating contexts, might perceive more choices with consequent lower decision costs. Consequently it might be easier for them to broad frame the situation and take a more analytic and less emotional approach to risk. Indeed, systematic ignorance of details due to perspective distance has been suggested as a prerequisite for risk analysis (Merkelsen 2011). This view has been supported by risk analysis work by the authors in museums and archives where effort is required to help professionals with close ties to specific collections to let go of strong feelings about quantitatively small risks: to ignore, literally to become ignorant of, those feelings.

In situations with perceived significant consequences it is useful to recognise that people have different emotional reactions to action and inaction. People may have a stronger reaction to an outcome produced by an action than inaction (comparable to sins of commission versus sins of omission) (Baron and Ritov 2004). The greater the consequences for the decision maker the more time they will spend and the more risk averse they are likely to be. Where a decision maker believes that the consequences of their decision will be scrutinised they will show a strong preference for inaction (Kahneman 2011 204). Where choices are restricted, consequences are high and scrutiny is likely there will be a strong pressure to being risk averse and to create a bias towards inaction. An awareness of these pressures prepares the conservator to recognise the possibility of a bias against active solutions (such as relaxing the humidity control settings then directing the consequent financial savings to improved storage cabinets) by identifying maintaining the status quo as a passive and inactive choice and as being only one of a set of options.

Satisfaction [sub heading]

Another factor to consider when studying preservation decision making is to consider what relative importance is placed upon outcomes being risk-quantitatively correct versus those outcomes being socially satisfactory in terms of how people experience their life. For some situations an outcome may be both correct and satisfactory but in others these may be different. For example, people often face situations where they know that taking the path that they feel they ought to follow could lead to conflict and unhappiness so they must choose between what they 'ought' to do and what would be 'easier' to do. Although deliberation may point to the more worthy 'ought to' option a recognition of the value of heuristics should encourage the decision makers to take their instinctive unease seriously. When making such evaluations in a professional context a decision maker should reflect on the outcomes required by critical stakeholders such as employers or trustees. The heuristic (type 1) unease can be recognised, prompting reflection (type 2), the outcome can be either one that which feels emotionally more satisfactory or one that can be more logically

defended, such outcomes may be the same or different. Being aware of and considering both types of cues may help a conservator to more clearly define and pursue their goals.

Resources [sub heading]

The choice of decision making strategy may ultimately be determined by the resources the decision maker is able to muster. Resources can include expertise, budget, time, availability and even the patience of the decision maker. An assessment of resource availability must be honest. Few people employed in collection care would consider they had little to do or a surplus budget that they cannot work out how to spend. The key is recognising when to rely on intuitive expertise and when, and how far, to take an analytic-deliberative approach. In some cases the assessment of resource availability may result in a commitment to seek additional resources to fund research and reduce uncertainty. In some cases, however, nothing can provide more time or money and resources must dictate the decision making strategy. It is also important to recognise those situations where additional resources and increasing sophistication in the decision making approach are not expected to improve decision quality or the utility of the outcome. For example, an initial response to a high humidity event resulting from a localised flood in a museum in a temperate zone could be to immediately ventilate the building within the limits of security. That enacted decision might only be moderated, if necessary, after a period of data collection.

Decision making strategies [heading]

Heuristic judgements [sub heading]

Heuristics are quick intuitive mechanisms that everyone uses to make many of their daily decisions. Heuristics help people make decisions quickly, sometimes by substituting an easy to answer question for a trickier one. For example, if asked to rank the population of German cities a football fan may rank them in the order of the success and fame of their football teams (Gigerenzer *et al* 1999). Heuristics were necessary for the evolutionary success of humans and remain essential for functioning in today's world. Although they are prone to predictable biases, many heuristics can operate on a par with structured analysis approaches and can, in some circumstances, result in more rational judgements (Gigerenzer 1999 *et al*, Stanovich 2009, 2011).

Heuristics are traditionally associated with a set of biases that can be recorded and described (Kahneman et al 1982). Bias in decision making tends to follow the availability of information. Recently discussed, interesting or alarming issues may play a bigger part in a person's perception of risk (Ashley-Smith 1999, 19, Slovic 1987). Heuristic decisions have been shown to be better at dealing with frequency than probability. Heuristics have been shown to be effective at identifying preferable solutions from a set of options (Kahneman et al 1982, 164 and Gigerenzer, 2000).

Compound risks where a series of events must all happen for the consequences to arise are subject to well recorded bias. People have a tendency to over or underestimate the cumulative impact of risks depending on their assessment of the likelihood of the individual events (Kahneman et al 1982 p16). In preservation this may result in either over stating or ignoring the risk of a combined power failure, public holiday and high water level that could lead to a disaster. Ignoring compound small risks may be essential when decision making under pressure such as a disaster response but is ill-advised when time and resources permit, such as in emergency preparedness planning.

Heuristic decision making avoids data rich analytical processes, opening up the potential for decision making based on a broad discussion of issues. This discussion offers the possibility of engaging a wide group of stakeholders on terms that they can relate and contribute to (Sloggett 2009). Emotions and senses can feature in heuristic decision making, encouraging participants to consider the broadest context of a decision. As factors need not be quantified to be considered there is no limit to what can be included in the decision making process. In the best case, this can lead to transcendence of differences and the discovery of hitherto unforeseeable options and solutions to dilemmas. In the worst case, selective avoidance of evidence, and a lack of a structured model, will allow emotionally or politically charged options to be pursued despite strong empirical evidence of potential negative consequences. The opportunity for open ended engagement with a broad group of stakeholders to explore the big picture is a unique strength of the heuristic approach.

Conservators engaged in shared decisions about preservation and use may approach a request to wear an item in the costume collection with a concern for the strength of the stitching or its vulnerability to staining. A user community may wish to establish whether an activity undertaken whilst wearing the garment is restricted by the size and construction of that garment. Allowing a broad and open discussion about all plausible benefits of the use proposed, before any efforts at quantifying costs and benefits may enable broad reframing and discovery of innovative solutions. If the activity has a positive impact on the significance of the collection as a whole then decision analysis from the perspective of the individual item may lead to a suboptimal decision from a collection, institution, or society perspective. Opening the discussion to explore all concepts without demanding their quantification can sometimes avoid unnecessary and unproductive material versus emotional polarisation.

In contexts where heuristic decision making is acknowledged and embraced it is possible to identify common weaknesses. This allows the construction of strategies to counter those weaknesses. One such bias is hindsight bias: where people fail to learn from mistakes because memories of past experiences are re-configured by factoring in evidence that becomes available after the event. The inability to strip out recently acquired knowledge relates to the way that memory is constructed (Hertwig et al, 2003). A simple habit of keeping a desk diary or reflective log is a way to protect and learn from this. So, for example, most disaster response strategies should recognise the desirability of heuristic

decision making in the immediate response. However it may be hard in hindsight to appreciate the pressures on a manager deciding whether to enact the Emergency plan in response to a severe weather warning after that weather event has, or has not, occurred. Recognising that in an emergency, heuristics are desirable means that the predictable hindsight bias can be managed by good logging of the crisis management. Another common heuristic is for our minds to replace a difficult question with one that is simpler to answer, known in psychology as 'attribute substitution' (Kahneman 2011). In preventive conservation this has frequently manifested itself by replacing the question: 'Is this gallery providing conditions in which my organic collection items will not be strained beyond their elastic limit due to fluctuating humidity?' with, 'Is this gallery at 55% ±5 RH?'. Defining goals carefully and setting them at the forefront of activities will help protect against bias. This can be as simple as ensuring that mission statements and project goals are restated at the start of discussions. Revisiting clearly stated goals during a project will also help diagnose whether the operation is successfully delivering on the goals or has descended into delivery of a procedure independent of goal achievement.

Heuristics rely on using very few simple cues to make a decision, which means that some factors which could be considered are not used to make the decision (MacGilvray 2014). This strategy is not necessarily ineffective: for example lay people have been shown to be successful at investing in the stock market by creating a portfolio of companies based on name recognition alone with no examination of company performance or the track record of the CEO (Gigerenzer *et al* 1999). The speed and simplicity is the source of both the strengths and weaknesses of heuristics. They allow big picture decisions to be made quickly, perhaps gaining the benefits of a limited time opportunity and, by saving effort, they free the decision maker to concentrate on other tasks. An important factor to consider in evaluating the acceptability of a heuristic is its opportunity benefit and cost. That is considering the cost of the potential reduction in precision and decision transparency versus the gain of the alternative use of the decision maker's time and attention. A conservation manager planning the relocation of part of a museum's collection to an industrial store may simply exclude the option of including the fine art collections in the move, to avoid complex negotiations for the requirements of the building. The time saved might instead be better spent in discussion with colleagues to identify the specific requirements of the archaeological reserve collection (Gwilt 2008).

The ability to select and evaluate one or two simple cues which work well to predict outcomes is another element of a successful heuristic decision. Research in psychology has found many such cues used effectively both in the natural world such as a rabbit's recognition of predators or a bird's strategy for feeding their chicks (Gigerenzer *et al* 1999, 235, 311) and in human concerns, such a name recognition for financial investments or football success for population size. These simple cues have been shown to offer reliable, predictive relationships which can even result in more reliable outcomes than when some data is added to the decision making process (Gigerenzer *et al* 1999). Knowing if a cue is

useful is critical, for example, a schedule overrun on a construction project could be reasonably predictive as to whether there will be sufficient time left to safely install an exhibition but it may not be a useful predictor for the quality of the build. Reflection will help one decide whether using a simple question in place of another more complex one is effective.

Heuristics, expertise and efficacy [sub heading]

A trained conservator carries out a condition survey and spots a hint of salt subfluorescence forming in a terracotta figure. This single cue, coupled with knowledge of RH instability in the storage environment, suffices to automatically assign the item to the 'needs conservation' category without any further assessment of the surface soiling or fine cracks. A less experienced surveyor may not identify this critical cue and could continue to collect accurate but essentially superfluous data on cracks and dust layers perhaps even missing the key feature, subfluorescence. This example illustrates several points. Data on surface dirt and cracks is meaningful in describing the figure but despite its validity it has poor correspondence with preservation needs. If directed to look for signs of salts (i.e. directed to the critical cue) the novice could probably arrive at a coherent recommendation for its care. Making the expert write down the amount of dust and checking seven other condition boxes will do little to improve the usefulness of their assessment. The quality of the heuristic is therefore related to the ability of the assessor to identify key decision cues which, in this example, are indicators of risk.

The value of instinctive and hard to quantify judgement is easy to recognise in conservation contexts. The feel of an organic material that has been humidified in order to manipulate it or the choice of tone for a gap fill can be recognised as excellent within the community of conservation practice. The best terms to describe how the outcome was achieved such as 'it felt right' reflect the intuitive qualities of heuristics at work, yet this description could appear to be a less developed form of thinking. The recognition and valuing of implicit knowledge, such as craft skill, helps the conservator to work with both hard data and expertise. Professionals may avoid acknowledging heuristics in public contexts as this may seem inappropriate in professional literature. In a formal paper it would be easier to state that a gap fill had a CIE measurement of XYZ and compared this to the CIE description of the original material, than it would be to say that the resulting fill had a satisfying neutral tone that was like the original but just a little more subdued. Yet most fills are chosen by their ability to satisfy client and conservator than they are by their instrumentally measureable condition. Any apparent preference to work with things that can be objectively measured (Hedley, 1993) or to 'immerse themselves in the technical aspects of their work,' (Ward 1986, vii) may reflect less on the specific practice of conservation and more on the acceptable form of public discourse about conservation and science more generally. Hedley (1993, 152) argued that conservation decisions 'are not matters that can be solved solely by reference to material facts'. It is because things such as 'intuitive visual judgements' with their associated aesthetics and emotions have validity in conservation that heuristics are an

essential part of the conservators decision making tool kit (Hedley 1993, 157). In a profession, such as conservation, where materials science underpins so much of the approach, developing a confident understanding of decision making and specifically a vocabulary to describe heuristic judgements should improve discourse and offer greater opportunities for reflective learning.

Expert judgements arise from skills and knowledge that are learned well beyond the minimum needed for competency: they become intuitive, type 1, thinking. Consequently the expert will have limited insight into how their day to day decisions are reached. 'An expert's skill has become so much a part of him that he need be no more aware of it than he is of his own body' (Dreyfus and Dreyfus 1986: 30). In situations with high consequences and where there is time for thinking before acting Dreyfus and Dreyfus (1986, 32) argue that the experts do not turn to analytic-deliberative means for problem solving but instead reflect critically on their own intuitions and this understanding has been confirmed by more recent research on decision makers such as fire fighters (Klein 1999). Heuristics can be effective and accurate or they can be quick but inaccurate. Knowledge, experience and expertise can impact on which they are. Heuristics are, in all cases, the default means for making decisions.

A conservator charged with the care of a furnished period house may notice on a rainy day that the visitor numbers are unusually high. Their intuition could signal this being an exceptional event with possible negative consequences. The conservator might decide to drop their task in hand and take action. Actions could be anything from restricting numbers visiting the most vulnerable rooms, changing the access routes or even to seeking monitoring data. The instinctive decision that action is needed is arises out of expertise based on years of experience and accrued knowledge. Even the decision to seek more data, although being an analytic-deliberative strategy, was triggered by a heuristic one.

Uncertainty and heuristics [sub heading]

Uncertainty is a feature of many museum operating contexts. For example 'how will this fifteenth century table respond to a 15% drop in relative humidity level over an eight hour period?' or 'How much funding will we have in a decade's time?' are questions that conservators may consider. Whilst it is possible to predict the fade rate of a range of materials and pigments with increasing precision, it would rarely be possible to fully characterise all the materials included in a composite 'found art' piece. Much research work has been done to reduce uncertainty in conservation, most papers in this journal attempt to do just that but many questions remain unanswered. The world abounds in random variability, as well as knowledge deficiency, so uncertainty can never be entirely eliminated. Even in cases where (epistemological) uncertainty could be reduced by further fact finding, the time required for data collection may delay a decision beyond the time in which it could be usefully taken. By focussing decision processes on identifying and prioritizing meaningful cues, heuristics can provide answers in conditions of uncertainty without multiple options

needing to be scrutinised, evaluated, quantified and compared. The conservator responsible for the fifteenth century table could seek certainty that the table would be damaged, but in seeking certainty before acting the opportunity to prevent damage may be lost.

Analytic-deliberative process [sub heading]

Despite the prevalence of heuristics, in some situations people adopt the more cautious, detailed, but costly analytic process. The analytic process involves a systematic structuring and evaluation of knowledge and evidence by decomposing a question into component parts. Within limited, highly technical realms an analytic process can be designed and completed by an expert individual. For more complex issues, analytic-deliberative decision making provides a route whereby the expertise of the individual decision maker can be augmented by structured integration of external expertise. Deliberation allows multiple and diverse opinions as well as social values of multiple stakeholders to be expressed and considered. The analytic–deliberative process enables the meshing and interplay of the two processes. It enables data and evidence to inform opinions while allowing values to influence weights given to data. Many heritage organisations utilise cost benefit mechanisms to prioritise decisions or integrate concepts of significance with condition to plan the deployment of conservation budgets (Cassar 1998, Keene 1996).

Analytic-deliberative, more than heuristic decision making, is the recognised form of decision making within scientific disciplines. There are many models for such decision making, including AHP (Saaty 1980), multi attribute utility theory (MAUT; Edwards and Winterfeldt 1987), multi-criteria decision analysis (Giove et al 2010), Bayesian reasoning (Darwiche 2009) cost-benefit analysis (Cassar 1998) and these are widely respected and utilised. Given the diversity of analytical decision making techniques this paper focusses on decisions for risk management to examine the application of analytic-deliberative decision making in a conservation context.

Analytic – deliberative processes and cultural property risk analysis [sub heading]

In planning preservation a well-structured and appropriate risk model is essential for efficient direction of resources (Waller 2002, 2008a). A comparable form of structured risk model for engineered systems has been described as a Hierarchical Holographic Modelling (HHM; Haimes 1998). A model of this kind can be used to establish a sense of completeness of risk accounting (Waller 2008b) which is critical for ensuring priorities are not based on a subset of actual risks that happens not to include the most serious risks. The importance of a deliberate, well documented, and transparent approach to comprehensive risk identification has long been recognized within the risk analysis field (Kaplan and Garrick 1981, Kaplan et al 2001). In conservation there remains a sense that this process can be rapidly achieved using ‘common sense’ (Michalski 2014). Misapprehension of the significance of risk scenario structuring can result in increased overall risk by diverting resources from more significant but non-assessed specific risks.

One of the greatest strengths of an analytic-deliberative decision making process is that it can focus evidence gathering effort where it is judged to have the greatest value for decision making. Collection risk assessments commonly demonstrate Pareto distributions to risks when profiled by generic risk (kind of hazard), by collection unit (part of collection), or other partitions useful for disaggregating risk (Waller 2008b). Pareto distributions reveal which factors are of dominant importance over others. These factors could be risks, parts of collections, locations within a museum, among others. Figure 1 shows an idealized Pareto distribution demonstrating how strongly a limited number of factors can dominate a quantity like risk and its distribution: a risk profile. In some contexts it is possible that an expert could readily heuristically identify the highest risks, for example collections held in challenging settings, such as an industrial warehouse or outdoor settings where a few risks are outstanding. In situations where the most egregious risks have already been mitigated a more formal process is likely to be required to identify the highest risks. It is also possible to rank the risks through a series of simple, heuristic judgements but this becomes more impractical the greater complexity of the context.

Arguably the greatest importance of adopting an analytic–deliberative approach is enabling well-documented decisions to be made in situations where a lack of timely and meaningful feedback prohibits experiential learning. Most of the decisions made in support of preventive conservation do not lead to measurable effects within a context and timeframe that supports learning. For example a decision to house a collection in water resistant containers instead of thoroughly cataloguing the collection cannot be quantifiably studied by conducting a contrasting experiment with reversed priorities. Whereas both heuristic and analytic-deliberative decision process could lead to a decision to house the collection in water resistant containers, only analytic-deliberative would offer a fully argued account of the options considered and how each was evaluated. That documented accounting could be revisited after a significant passing of time which might contribute to learning. Given the difficulty of gaining feedback during conservation practice the ability to reflect and learn from the decision making of predecessors may ultimately be the greatest benefit of the process. Sadly, the lack of learning-enabling feedback within conservation may be poorly addressed and success could be measured by the delivery of the process rather than by reduction in damage. This would be an example of a poor cue substitution.

Expertise and Feedback [heading]

A critical feature of a decision making process is the degree to which the decision maker has truly relevant expertise. True expertise can be described as the ability to quickly recognize critical factors in a situation and choose the best option in the context (Klein 1999). Experience can lead to the development of effective heuristics which form a basis for expert decision making. Experience without timely and meaningful feedback can lead to both false expertise and over confidence. In this case the repeated enactment of a common practice leads to stagnation and dogma perhaps bolstered by a false sense of expertise.

Heuristics operate with or without true expertise and superficially both expert and inexpert decision making processes appear similar. Expertise which has become intuitive offers little opportunity for insight as the expert simply knows that something is correct (Dreyfus and Dreyfus 1986). When questioned, the expert may not be able to describe how they know this. Still, the expert's insight is fundamentally distinct from a novice's guess. Although neither expert nor novice can offer an analysis of their decision making process one is quick, effective and accurate while the other relies on luck. It can be tempting to correlate expertise with experience however experience is no guarantee of the development of true expertise.

Experience only leads to learning if a clear cause and effect link exists between action and consequences and it is possible to identify critical success factors (Shanteau 1992). Klein (1999: 104) argues that experts learn by deliberate practice where each opportunity for practice has a goal and evaluation criteria. By developing an experience bank and getting feedback that is accurate, diagnostic and timely we become experts. Without feedback, repetition, stable context, etc. experience may not lead to expertise. It is not having experiences that matters - it is what you learn from them (Shanteau 1992). Dorner (1996) provides a good description of the problem:

> "Methodism is likely to flourish in those situations that provide feedback on the consequences of our actions only rarely or only after a long time. In particular, if our plans apply to a field in which we rarely act, our planning gradually degenerates into the application of ritual."

A lack of timely and clear feedback is a major challenge for preventive conservation and preservation management. It can lead to methodism including, but not limited to, adherence to nominal standards beyond their limits of appropriateness. The continued disconnect between some sectors of the conservation field over environmental specifications (Atkinson 2014) is just one example of a tension of procedure over outcomes.

Expertise is context dependent, it is only if experience and feedback are acquired in situations where critical success factors map well to the current situation that true expertise can be called on. A good correspondence of cues and outcomes is termed validity (Newell et al 2007).

This definition of expertise could be problematic for conservation. In many cases the outcomes of conservation solutions are tested over decades and without controls, reducing opportunities for meaningful feedback. Where an action is repeated and verified, such as creating a repair in porcelain, expertise can be developed by the practitioner. Where the action is strategic, such as setting environmental control parameters it will require careful goal definition to enable the opportunity to measure and reflect on, at least interim, outcomes. The conclusion need not be to reject heuristics, but it may be that conservators responsible for strategic decisions could include in their continuous professional

development (CPD) allocating time to reflect on the quality of the feedback that they gain on their decisions.

People invariably create stories to explain observations. Low validity situations lead to false stories in which conclusions are not supported by evidence. This is the source of most superstitions like having a lucky charm and ascribing good outcomes to its presence. The saying 'a little knowledge is a dangerous thing' reflects the danger of over interpreting the relevance of some cues without fully understanding the context. Trying to apply specific items of knowledge without being aware of their place and limitations can lead to incorrect decisions and poor outcomes. Unfortunately, there is often little correlation between the confidence of a decision maker and validity. A declaration of high confidence tells you there is coherent story but not necessarily if it is true (Kahneman 2011).

In some cases feedback can be obtained by sensitive measurement, for example, measurements of ΔE for fading colors. It would be hopeless to expect a conservator to develop a good judgment of relative fading rates for different moderately stable oil colors simply by walking through a gallery over the course of their career. In contrast, it is a relatively simple matter to instrumentally measure ΔE and combine this with light exposure data to calculate fading rates. It is also possible to conduct studies of the effects of preservation methods alternatives (Keene and Orton 1985). Still, these favourable situations for valid and timely feedback remain exceptions more than rules when considering the broad range of risks to cultural property.

Comparison of heuristic and analytic-deliberative [heading]

Having described heuristic and analytic-deliberative decision making it is beneficial to consider their use in a range of contexts. In particular, data requirements, including both quality and type are considered. The problem of illusion of accuracy is identified and discussed as are the interrelated issues of detail, focus and expertise. Finally, situations appropriate to heuristic or analytic – deliberative approaches, or some combination, are described and specific cases examined.

Data for decisions [sub heading]

Data quality [sub heading]

Where a choice between heuristic and deliberative decision making is available an important resource to evaluate is the nature of the data available? Is it sparse or comprehensive? Is it subjective or objective? Is it vague or precise? Is it clear what additional data is required and whether it can be collected? If new data can be collected it must be similarly scrutinised. The more abundant the data is, or has the potential to be, and the less uncertainty and subjectivity associated with it the more opportunities there are for number crunching traditionally associated with analytic-deliberative decision making.

The data that is, or could be, available should be examined for its coherence, its potential to predict an outcome. In making this evaluation a decision maker should ensure that the apparent coherence of the data has genuine and independent predictive value and is not simply correlated with the source (Kahneman et al 1982:65, Cox 2013). Knowing the goal for the research that created data can be helpful in evaluating the coherence of the data available to prediction of an outcome. Where data that is not coherent with an outcome is used it is unlikely to produce a useful outcome regardless of the form of decision making. For example, knowing the concentration of chloride ions in archaeological iron will help predict its stability and govern the frequency of silica gel changes. Equally, knowing that no-one can remember the last time the silica gel was changed is a good prompt to go and change it. In these examples both analytic-deliberative and heuristic cues are likely to be coherent. By contrast choosing a strategy of changing gel on a schedule that is not correlated to air exchange of the boxes, or operating a habit of changing the gel in the boxes at the front of the store, would be poor decisions from either mode of decision making.

Data type [sub heading]

Some kinds of data are better handled with analytic-deliberative rather than heuristic processes, for example, probabilities, non-linear scales and decimals. Heuristic processes work more easily with frequencies, changes, and patterns (Gigerenzer 2000, Kahneman et al. 1982: 11, 164, Newell et al 2007: 102).

People naturally think in terms of linear projections even though both natural and artificial systems often depict nonlinear behaviour, such as exponential growth or catastrophic decline (Meadows 2008). For example, a conservator might reasonably expect that doubling the exposure to light will double the rate of fading of fugitive colours. In contrast it might be quite wrong to expect that changing from an RH variability of +/-1%RH to +/-10%RH increases rate of deterioration or damage by a factor of 10. The real effect of that difference in RH variability could be insignificant, devastating, or anything in between. In the case of heuristic judgements, whatever scaling is used in reaching a decision is tacitly embedded in the decision and not (readily) available for critique. By contrast, in a deliberative model the scale for relating inputs to outcomes must be made explicit and is therefore available for review. In simple term a sportsperson can successfully catch a ball without being able to describe its speed or direction of travel. An aeroplane pilot who was unable to describe the flight speed or direction of travel would not be evaluated so positively, in both instances there is best fit for decision making, each individually valid in context.

Where numbers are described as fractions, especially small fractions, people have a tendency to see distinctions as irrelevant. For example, many people may not distinguish the difference between events with likelihoods of say 0.01, 0.00001, or 0.00000001 seeing them all as ‘tiny’ even though the expected value of the risks are one thousand or one million times smaller. With such precise absolute numbers heuristics may be ineffective, but if emotional decision are involved then communication of orders of magnitude may need to

be presented in a different way, for example describing small probabilities to patients in medical contexts can be managed by converting numeric data into visual data (Fuller et al 2002).

Perceptions, as other heuristics, are better attuned to differences rather than the evaluation of absolute magnitude. Whereas staff might not be able to estimate the actual temperature in their work area precisely, nor care, a change of just one degree Celsius could be readily perceived with extreme prejudice. Emotions are triggered by change (Kahneman 2003: 706). Whereas an analytical process would consider a change in value to be accurately described or characterized by its numerical value, heuristics convey how people experience a change in value according to context. This relates to the satisfactoriness of a change of state. (Kahneman and Tversky 1979). A shipping case containing a painting is accurately described by its weight and this would be an essential piece of data to collect and utilise, for example in planning suitable lifting equipment. The experience of the weight of the crate for an art handler will change over the time it is carried which may become a significant factor in assessing whether it is likely to be dropped.

Heuristic and analytic-deliberative decision making processes have been identified as having strengths and weaknesses. It is evident that playing to a decision making strategy's strength will increase the likelihood of good outcomes while aligning with weaknesses will increase the likelihood of poor outcomes. Further, being aware of which mode of decision making is being employed allows the user to operate appropriately, consistently, and mindfully. Making decisions using heuristics is instinctive and it may not be immediately apparent that a decision is being made, especially where the decision is to do nothing. Dangers that could arise from entrenched or ritualized decision processes include loss of meaning and an inability to note exceptions (for example reams of environmental records collected but not effectively acted on), post event rationalization (for example accepting deterioration as inherent vice rather than identifying and providing conditions necessary for preservation), or the illusion of objectivity. The heuristic decision to do nothing or to accept the status quo may not be recognised. Developing an ability to recognise heuristic decisions to take no action and the situations in which these are likely to occur, offers the conservator the opportunity to question the efficacy of such passive choices.

Illusions of objectivity and accuracy [sub heading]

Data can create illusions of power and objectivity. Consequently, decision makers should know or establish the limited relevance for any data they hold or plan to create. There are many advantages of careful analytic–deliberative decision making but these are lost when a rational house is built on irrational sand. This could occur if the model is incomplete, poorly structured or not populated with data. Can and will subjectivity be adequately controlled? If not then a heuristic or subjective decision might be substituted for the process with no decrease in validity but a significant reduction in effort.

The illusion of accuracy can also be problematic. The results of quantitative risk analyses can be reported as point estimates (single numbers) usually chosen to represent upper probable bounds, or similar, limiting value. Unfortunately, these numbers appear precise and convey an unwarranted sense of accuracy in both audiences for and users of the data. As a precaution against this, quantitative results can be expressed as distributions (Waller 2003). Unfortunately, these are often naively based on only uncertainty in variables and neglect the often much greater uncertainties in model structure and underlying assumptions. Hence, this apparent antidote to illusion of accuracy can exacerbate the problem. Precise data is like a sharp tool, it can be very effective but requires constant care in use to avoid harm through clumsy use.

In planning for collection care, conservators are inevitably faced with uncertainty (Ashley-Smith 2000). The way that a decision maker responds will be different for analytic-deliberative or heuristic processes. A decision maker using analytic-deliberative techniques would ideally calculate the 'value of information' (VOI) to determine priorities for reducing uncertainty. VOI provides a measure of how much additional information could improve a decision by removing uncertainty. Heuristic decision makers may by-pass the lack of certainty by using modeling techniques such as attribution substitution, focussing on effective cue selection and prioritisation.

People create stories as rationales to explain the data presented. Sometimes strikingly, when conflicting data is encountered people tend to retain their rationale and dismiss the data is as irrelevant (Kahneman et al 1982 p150, Tetlock 2005). This urge to seek and recognise only data that confirms a prior opinion is familiar to anyone that has scored options on a rational scheme and then decided that the outcome was 'not right' so the weighting scheme was re drawn to 'get the right answer'. This was the case when the U.S. Army wanted to design a rational and transparent system to decide which collection repositories should receive artifacts recovered from military owned lands. To accomplish this, the Army Corp of Engineers designed a rational decision analysis approach supported by the analytical hierarchy process. Although museum experts contributed to the design of the system and made judgements to rank options, in the end the museum experts overrode some quantitative rankings with their intuitive senses of appropriateness (Department of Defense and U.S. Army Corps of Engineers 1999). It would be inappropriate to judge this particular analytic-deliberative effort a failure simply because it did not quantitatively define an optimum answer. The system could not do that because political considerations were not included as quantified factors.

Experts questioned on their decision methodology are often able to invent plausible descriptions of their decision making processes. However, as with the example of the revised ranking score this 'explanation' works back from the outcome and describes rather than predicts the process. It is a form of post event rationalisation. The danger is that a process which is apparently analytic-deliberative because lists and scores were used is, in

reality, a covert heuristic decision. This confusion is a worst of both worlds scenario, the time and effort is expended but the possibility for heuristic bias is neither acknowledged nor mitigated. Where an outcome arrived at by an analytic-deliberative process does not 'seem right' that sense should be recognised and prompt a re-calibration of the analytical technique, re-examining and re-visiting the underlying assumptions to uncover either where the analytic error resides or why the intuitive sense of 'seem right' is wrong. Either could be the case.

Detail, focus and expertise [sub heading]

There is a danger in detail. If every option is analysed then heuristics and associated biases can be avoided but at the risk of getting bogged down or lost in the detail. For an expert, involvement in detail can be a distraction, for the inexpert decision maker, as well as for experts with too many details to remember (such as pilots preparing for departure) then running through checklists is useful. Fortunately, both detail and overview can be accommodated through systematic, hierarchical structuring from a goal through to details (Waller 2002).

As expertise grows the opportunity for effective and accurate heuristic decision making follows. A defining feature of experts is their ability to pick out critical cues: those elements of a complex situation which define the outcome. Once selected it is possible to evaluate these few cues in either a simple heuristic way or in a detailed data rich manner of classic rational decision making. This filtration process by experts can perhaps offer the best of both worlds, a quick and effective cue selection process followed by a detailed rational analysis of the much reduced and focussed pool of concerns and options.

Uncertainty is inevitable. If the response to uncertainty is always further data gathering then the decision maker has entered an infinite loop. The ultimate decision making skill is knowing when and what data or evidence to seek and when to act despite uncertainty.

Issue structuring, data collection and analysis are important features in the analytic-deliberative process. For heuristics the emphasis lies more in cue selection and prioritisation (Kahneman et al 1982, Gigerenzer et al 1999, Martignon 2001, Newell 2007, Henderson 2011). When an analytic-deliberative approach is adopted some considerations which do not translate easily into quantitative measures may be pushed aside. Needing to quantitatively evaluate a cue may exert a subtle pressure: encouraging decision makers to consider fewer variables or options and to focus their evaluation on cues which are most readily quantified. Some stakeholder's concerns, such as intangible values or ethical concerns, may be hard to quantify and incorporate in an analytic-deliberative approach leading to soft issues being excluded from analysis (Sloggett 2009). Heuristics as a decision making strategy which focuses on evaluating cues can easily incorporate criteria which are difficult to quantify.

Outcomes derived from analytic-deliberative processes will appear to be more 'correct' than heuristic outcomes. This can provide a toe hold for a sanctimonious attitude on behalf of advocates for analytic-deliberative decision making. However, the accuracy of analytic results only hold in the context in which the problem was framed. Forgetting this limitation creates the possibility of applying findings beyond their relevancy. This skewed vision tends to prioritise technical issues over social or political ones. It is a well-recognised phenomenon in the risk analysis community where it is known as technocratic overreach. This may be the most insidious of the problems that can arise from application of analytic processes to preventive conservation decisions.

In the case of heuristic decisions, the insidious danger, aside from the issues of biases discussed above, is a tendency to settle into habitual, even ritualistic, decision behaviours which can be not just non-productive but even counterproductive. Demanding that an archive collection most at risk from progressive chemical deterioration be maintained at 50% RH instead of a lower value is a classic example of this problem (Pretzel 2005).

Situations for heuristics or deliberative [sub heading]

The context in which decisions must be made will influence which type of decision process is more appropriate. Significant factors include: must a decision be made rapidly; how repetitive are the decisions; can reliable rules be codified (either on paper or in the mind of the decision maker); how knowledgeable and experienced is the decision maker and how relevant is past experience to the current situation. These issues have been discussed above and are summarized in Table 3 for easy reference and comparison. For a simple decision, such as the location of an insect pest trap within a room then the method can either be heuristic when installed by a recognised pest expert, or analytic-deliberative if museum volunteers are brought in and are supplied with a checklist of ideal locations. More complicated situations, such as creating the IPM strategy for a whole museum are likely to contain a series of decisions made using both strategies.

Heuristic decisions maybe be effective when:	**Analytic-deliberative decisions may be when:**
Many repetitive, similar decisions must be made.	The consequence of an incorrect decision is high.
The decision maker has good reason to be confident.	The decision maker has insufficient relevant prior experience.
Expert sense cannot be replaced by a technical measurement or combination of measurements.	There is little or no timely feedback on success of similar past decisions.
Factors best represented by intuitive knowledge are dominant or very important	Stakeholders must see that multiple factors are being considered jointly (transparency).

(e.g. human relations). Resources for decision making, including time, are necessarily limited. Creative outcomes are required. Sensory judgement required (e.g. feeling adhesion of a paint layer during removal with a scalpel).	Factors best determined by technical measurements are dominant or very important (e.g., degree of polymerisation). Benefits of accountability justify resource use.

Table 3. Guide to matching decision making process to context.

Situations favouring a heuristic approach [sub heading]

Heuristics are the default for decision making. Concerted effort is required to move to analytical thinking. This default setting has been shown to be evolutionarily valuable (Gigerenzer et al 1999) and when used by experts in appropriate contexts can deliver high quality outcomes with little effort. Heuristic approaches will be used in situations where time, cost and or sense of self efficacy in applying an analytical approach are limited. They may also be desirable in situations where broad social political factors play a dominant role.

Studies show that people use different criteria to evaluate a choice if given a single option as opposed to a pair or more (Hsee et al; 1999). In a single option evaluation decision makers respond to qualities innate to the object, whereas with a range of choices measurable comparators are more likely to be evaluated analytically. When asked to evaluate a single showcase it might be described as having a metal frame and reinforced safety glass and containing a tray for silica gel. When asked to evaluate two cases the air exchange rate, cost and time till delivery are more likely to be considered as there is the possibility to create data useful comparisons. Where a decision relates to a single option or problem the heuristic, cue oriented, mechanism may be the most effective (Kahneman 2011: 360) and an evaluation such as ‘is the metal frame a problem’ can address difficult to quantify issues such as design vision for the gallery.

Situations favouring an analytic-deliberative approach [sub heading]

Analytic-deliberative approaches are necessary when quantitative predictions must be made, when transparency of a decision process is required, and or where insufficient prior relevant experience exists. In high stakes decision making a deliberative process is likely to feel safer and is certain to be accountable. If a required decision outcome is a priority ordered presentation of options then an analytic-deliberative approach is required (Kahneman 2011 p415). This approach can be used to inform change, such as facility planning or policy development, but the goal and context must be sufficiently stable to ensure the decision outcomes can be generated within an acceptable time frame. Heuristic decision making has been shown to be vulnerable to predictable biases. Where these biases cannot be managed or avoided an analytic-deliberative approach may be the best option.

Whilst it may seem incredible that a large scale decision would be made based on heuristics, elements of the decision making process inevitably involve heuristics. This could be in a positive way such as aiming to raise a sense of civic pride via a building project. Or the heuristics may be involved in a disguised way such as using a significance framework to plan a large scale collection management project without recognition of the subjective, heuristic, elements with the mitigation of an ability to challenge or change the subjective elements over time.

Working together [sub heading]

Although it is possible to characterize decision strategies into heuristic and analytic-deliberative processes and allocate them to specific contexts, in reality many situations require a combination of both types of thinking. Where decisions require consideration of both technological and social concerns it is likely that both forms of decision making will have their place. Some overtly simple optimisation strategies over simplify problems and other formal multicriteria decision making strategies can become overly complex and difficult to operate within social contexts (Hassler and Kohler 2000).

At every step in a structured decision making process the value of seeking more information can and should be evaluated: both types of thinking offer value. Heuristics may be a useful precursor for considering and responding to broad factors prior to engaging in a more focussed analytic-deliberative process. Heuristics are also used to screen trivial details out of analysis. A 'gut level' check on the reasonableness of any analytic result would never be omitted by an experienced analyst as it provides a final means of catching egregious calculation errors. Further, on completion of an analytic-deliberative process the presentation and reception of the findings will be shaped by the heuristic assessments of the receivers. The analytic deliberative approach can only optimize within the bounds of rationally available options. If other, qualitatively different and quantitatively better options exist then they must be identified through an open minded, associative approach before they can be optimized through an analytic deliberative approach.

Using Type 1 and Type 2 processes: case study CPRAM [sub heading]

Having discussed the characteristics and applicability of heuristic and analytic decision processes in preventive conservation it is helpful to see how both processes are employed in conducting a comprehensive detailed risk assessment.

Initially, a heuristic decision is made regarding whether or not detailed risk analysis using a comprehensive model such as CPRAM is appropriate in a given situation. Institutions exercising either very low or very high levels of collection care may not benefit from this approach. For example, if as a consultant conservator you find that half of a mixed historical collection is stored outside the museum building in a non-enclosed space then recommending a move of that material into a secure space with a reliable roof might be justified without need for more detailed analysis.

Once engaged in the CPRAM process, type 1 thinking processes are encouraged to facilitate the kind of open, associative, creative thinking that is required for comprehensive risk and collection values identification. This process has been termed 'reasoned imagination' (Paté-Cornell 2012). Once a risk is identified, then alternating between type 1, open, and type 2, closed, analytical thinking is required to craft a definition of each specific risk that will be clear enough to allow quantification. In the next step, these well-defined specific risks are rank ordered by anticipated significance using a heuristic approach. In this case the validity of those heuristic judgments is ascertained by subsequent analytic–deliberative evaluation but the initial heuristic-based ranking remains an important part of the overall process.

Any analytic-deliberative decision process will necessarily include some subjective elements, such as 'value' in a risk assessment. Even before a scale of relative value is considered one must choose either a single, unified sense of value or decompose the total value into categories of value. One example of a set of comprehensive categories of value is the four primary criteria listed in Significance 2.0 (Russell and Winkworth 2009). The decision to either decompose the total utility value into component kinds of value, or to rely on the curator to consider an integrated, heuristically judged sense of value is itself a heuristic decision. The choice requires careful consideration and depends on characteristics of both the situation and the personnel involved. Ideally all subjective judgements will, through deliberation, approach a consensus that, although not objective, is at least 'collectively subjective'. If that cannot be achieved due to intractable individual differences then the necessary judgement must be dictated at the appropriate, higher hierarchical level. If judgements cannot be made robust in one of these ways then individual subjective elements influence, and could discredit, the analysis. Indeed any well-designed risk assessment model and process will facilitate rational validation of intuitive judgements before they are lost in the complexity of the decision process.

Finally, after all the disciplined analytic–deliberative work is complete, it is important to ensure that results are presented in a manner that takes best advantage of the heuristics of the decision maker you are trying to influence. That means purposely connecting with their heuristic interpretations of information in ways that will result in the most favorable impact. For example, the CPRAM enables reporting of magnitudes of risk as 'object equivalents lost' which is a much more salient, hence influential, representation of risk than a small ratio of collection unit value lost. This is not a recommendation to change the results, but to consider how the results will be received. On a more strategic level it can be about connecting to the vocabulary and priorities of the key stakeholders, in current UK terms, this might involve describing conservation recommendations as increasing resilience and representing solutions in terms of the opportunity for community partnerships. This might increase the chance of success due to the current popularity of terms such as 'resilience' and 'community partnerships' within UK politics.

Using Type 1 and Type 2 processes: case study collection survey [sub heading]

A scenario where both types of decision making can be imagined is a museum conservator considering a collection assessment. At the outset the conservator has a sense that they need to know their collection better to plan their conservation programme. This may be their first such project and they therefore do not have expertise. At this stage an analytic-deliberative process of collecting and reviewing options is sensible. As there are many different ways to evaluate collections their applications must be evaluated. A full statistical survey (Keene 1996) can generate a list of priorities and allow staff to investigate much of the collection, however it will also generate a mass of detailed data on every type of collection. A heuristic assessment might suggest it is improbable that they will get two new members of staff as a result of any assessment so collecting data to support such a request would be ineffective. The survey method can then be focussed either as a detailed survey of one part of the collection that has been heuristically assessed as being more likely to attract funding, or a different survey method chosen that identifies problems that may be solvable. The heuristic process helps with the formation of goals but an analytical deliberative process remains the best choice for data collection. The conservator then chooses a survey method which considers both collection need and value in order to show that actions can be prioritised as a combination of collection conditions and shared priorities (Xavier-Rowe et al 2008, Taylor 2005). The method may be detailed analytic-deliberative and involve as many steps as possible to reduce inaccuracy, subjectivity and bias (Taylor 2013). Another heuristic decision can be used at this stage: if for example, the current museum director has prioritised building community partnerships then that less quantifiable cue can be included in the formation of the project goals. In order to create satisfaction with their manager the conservator proposes to invite community partners to participate in the assessment of value perhaps utilising social media. This manner of embracing the non-certain qualities of value may seem less defendable in empirical terms than creating formal scales based on 'expert' judgement but may have significant benefits if resulting satisfaction levels are high. The consequent process collects the best possible data to a defined end together with an awareness of a context and other people's priorities that is most likely to lead to satisfactory outcomes.

Summary [heading]

So what is the appropriate way to make decisions? There is no simple answer. Some things can be stated with certainty. Portraying subjective data as objective is disingenuous and ineffective. If one has not faced similar problems in the past there is no expertise so it is likely that any heuristic decision will be strongly biased and possibly irrational. In this circumstance rational and competent behaviour has to be the default option (Dreyfus and Dreyfus 1986 p36). Many environments favour heuristics, especially those where decisions are repetitive, or where social factors have high importance and where resources are restricted. If and as opportunities arise these decision processes can be improved by reflective analysis and deliberation. Some environments favour analytic-deliberative

decisions, especially unique situations with high consequences. Those decisions can be improved if they respect the power and importance of heuristic processes in establishing judgements and in effectively communicating with higher level decision makers. Although the choice of decision making strategy is not always a conscious one this paper has sought to demonstrate that the ultimate goal is to be able to employ decision making strategies in their optimal context to achieve the best possible outcomes.

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Figure caption

Figure 1. Idealized Pareto distribution. Columns represent magnitudes of individual risks. The curved line represents a cumulative total magnitude of risk. © Protect Heritage Corp.